Energy Supplementation Sources for Lush Pasture

A. Bach, I.K. Yoon, M.D. Stern, H.G. Jung, and H. Chester-Jones

Introduction

Lush, vegetative forage as found in well-managed pastures is generally high in protein content. The high protein concentration in lush pasture can pose a ration formulation problem because of the high degradability of most forage proteins. Excess ammonia production from forage protein degradation in the rumen can result in insufficient non-ammonia nitrogen flow to the small intestine to support genetic potential for milk production by dairy cows. One method to overcome this problem is to supplement grazing cows with ruminal undegradable protein sources. However, this solution results in waste of forage protein, additional cost for supplemental feed, and increased nitrogen load on the farm. A more preferable solution would be to supplement cows on lush pasture with energy sources that maximize microbial protein synthesis and capture of nitrogen from rumen degraded forage protein. This experiment examined three different supplemental energy sources for microbial protein synthesis in a continuous culture system.

Materials and Methods

Forage was collected from a rotationally grazed pasture and freeze-dried. The pasture consisted of a complex mixture (approximately 50:50) of legume and grass species. As shown in Table 1, the forage was high in protein and had moderate levels of fiber and energy. Based on preliminary in situ experiments, three energy supplements (corn grain, beet pulp, and soybean hulls) were selected because they were isocaloric but differed in type and rate of carbohydrate fermentation. Protein levels in the energy supplemented diets were similar, but lower than for the all forage diet. Continuous culture fermenters were fed either forage alone or forage plus energy supplement in a 55:45 forage to supplement ratio. Fermenters were fed forage every two hours. Energy supplements were fed two times per day, at 12-h intervals, to mimic a twice-a-day milking situation where supplemental feed is provided after milking. Fermenter pH was allowed to fluctuate, but NaOH was used to prevent the pH from dropping below 6.0. The fermenters were operated in a single-flow mode with flow rate maintained at 0.07/h. Effluent was collected for determination of feed digestibility, bacterial protein flow, and VFA and ammonia concentrations.

Results and Discussion

The three energy supplemented diets resulted in lower average fermenter pH levels than the all forage diets (Table 2), but even the all forage diets resulted in large amounts of volatile fatty acid (VFA) production that required addition of NaOH to maintain fermenter pH above 6.0. Corn supplementation required the largest amount of NaOH addition to maintain pH. The acetate to propionate (A:P) ratio of VFAs was greatest for the all forage diet and least for the corn supplementation, and the soybean hull diet resulted in similar A:P ratios as the all forage diet. As expected, addition of energy supplements to the forage resulted in reduced ammonia concentrations in the fermenters, with the corn and beet pulp diets causing the greatest reductions (Table 2). Because the forage basal diet supplied most of the protein in the diets, no differences were detected among diets in protein digestion. Neutral detergent fiber and cell-wall polysaccharide digestibilities were highest for the soybean hull diet and lowest on the corn grain diet. Non-structural carbohydrates digestibility was greatest for the corn diet. While efficiency of bacterial protein synthesis based on amount of organic matter digested was the same across all diets, the corn and soybean hull diets improved the utilization efficiency of degraded feed protein (Table 2).

Addition of energy supplements to lush pasture diets may reduce nitrogen losses from readily degradable forage proteins by allowing more efficient capture of degraded protein as bacterial nitrogen. A readily fermentable fibrous energy supplement such as soybean hulls may be preferable to starch supplements such as corn because of less acid production and a higher A:P ratio of fermentation products.

Table 1. Chemical composition of dietary treatments.

	Diets			
Component[a]	Pasture Alone	Corn Grain	Beet Pulp	Soybean Hulls
CP	18.2	14.7	15.2	15.3
NDF	47.2	32.5	46.6	54.6
CWP	32.6	23.0	37.1	41.2
NFC	20.1	42.6	25.9	19.0
NSC	10.6	36.6	12.7	9.7
NE_L, Mcal/kg	1.54	1.68	1.65	1.65

[a]Components are in percent of DM unless indicated otherwise; CP (crude protein), NDF (neutral detergent fiber), CWP (cell-wall polysaccharides), NFC (non-fibrous carbohydrates), NSC (non-structural carbohydrates), and NE_L (net energy for lactation).

Table 2. Digestibility, fermentation characteristics, and efficiency of bacterial-nitrogen synthesis of dietary treatments.

	Diets			
Component[a]	Pasture Alone	Corn Grain	Beet Pulp	Soybean Hulls
Fermentation Characteristics				
pH	6.10^{b}	6.02^{c}	6.04^{c}	6.03^{c}
VFA, mM	126^{b}	142^{c}	124^{b}	152^{c}
A:P Ratio	4.01^{b}	2.46^{c}	3.05^{cd}	3.38^{bd}
NH_3, mg 100 ml^{-1}	10.3^{b}	2.1^{c}	2.6^{c}	4.4^{d}
Digestibility, %				
OM	37.8^{b}	54.8^{c}	45.8^{d}	46.2^{d}
CP	46.0	41.7	45.2	43.5
NDF	28.1^{b}	21.9^{c}	29.7^{b}	44.1^{d}
CWP	43.8^{b}	41.5^{c}	51.9^{d}	56.1^{e}
NFC	53.1^{b}	80.1^{c}	71.8^{c}	60.8^{bc}
NSC	64.9^{bc}	79.0^{b}	61.0^{c}	65.5^{bc}
Bacterial-N Synthesis Efficiency				
g N/kg OM digested	27.7^{b}	21.2^{c}	20.6^{c}	24.1^{c}
g N/kg N degraded	64.2^{b}	79.7^{c}	69.1^{d}	77.7^{c}

[a]VFA (volatile fatty acids), A:P (acetate:propionate), other abbreviations as defined in Table 1.